

REFERENCE ONLY

Report of The
Peer Review Committee

Tata

1987

TATA ENERGY RESEARCH INSTITUTE
7, Jor Bagh, New Delhi - 110 003



TATA ENERGY RESEARCH INSTITUTE

7, JOR BAGH
NEW DELHI-110003

April 13, 1987

Dr. R.K. Pachauri
Director
Tata Energy Research Institute
7, Jor Bagh
New Delhi - 110 003.

Dear Dr. Pachauri,

We, the members of the Peer Review Committee have great pleasure in submitting our report for your consideration.

We thank you for giving us the opportunity to review the work and working of TERI. For reasons beyond our control, we are sorry to have overshot the time limit set by you.

With regards,

Sincerely yours,

Arundhati Mukhopadhyay
Arundhati Mukhopadhyay

Ajay Mathur
Ajay Mathur
Veena Joshi
Veena Joshi

Leena Srivastava
Leena Srivastava

Sunil Khanna
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REPORT OF THE PEER REVIEW COMMITTEE

Table of contents

BACKGROUND.....	1
CURRENT STATUS.....	4
Policy and Planning Areas.....	7
1. Data Systems.....	7
2. Energy Environment Interface.....	7
3. Energy Modelling and Intersectoral Analysis.....	8
4. Fossil Fuels.....	8
5. Industrial Energy	8
6. Power Systems and Policy.....	9
7. Rural Energy Research and Extension.....	9
Technology Areas.....	10
8. Biogas.....	10
9. Brassica and Stress Studies.....	10
10. Cell and Protoplast Growth and Differentiation....	11
11. Molecular Biology.....	11
12. Tree Tissue Culture and Nitrogen Fixation Studies.	11
13. Chemical Energy.....	11
14. Renewable Energy Technology.....	12
15. Social Forestry.....	12
Service Areas.....	13
16. Computer Centre.....	13
17. Information Services.....	13
RECOMMENDATIONS.....	17
Infrastructural Problems.....	17
1. Space and Manpower.....	17
2. Experimental Fields.....	18
3. Equipment.....	18
4. Secretarial Staff.....	19
5. Inter-group Linkage and Interaction.....	20
6. Sponsored Research.....	20
7. Training Programmes.....	21

Future Directions.....	22
1. Research.....	22
2. Annual Symposium.....	24
3. Publications.....	25
4. Administrative Pattern	26
4. APPENDIX I: List of TERI Professional Staff.....	27
5. APPENDIX II: Detailed Description of subject areas: Objectives, Achievements, Constraints and Future Directions.....	31
Policy and Planning Groups.....	31
1. Data Systems.....	31
2. Energy Environment Interface.....	33
3. Energy Modelling and Intersectoral Analysis.....	36
4. Fossil Energy.....	40
5. Industrial Energy Efficiency.....	43
6. Power Systems and Policy.....	45
7. Rural Energy Research and Extension.....	49
Technology Groups.....	50
8. Biogas.....	50
9. Brassica and Stress Studies.....	52
10. Cell Protoplast Growth and Differentiation.....	56
11. Molecular Biology.....	57
12. Tree Tissue Culture and Nitrogen Fixation.....	60
13. Chemical Energy.....	62
14. Renewable Energy Technology.....	66
15. Social Forestry.....	69
Service Groups.....	72
16. Computer Centre.....	72
17. Information Systems.....	76
6. APPENDIX III: Publications of TERI Staff.....	84
7. APPENDIX IV: List of Training Programmes/Seminars/ Workshops conducted by TERI.....	100

1. BACKGROUND

In response to the Three Year Workplan developed by TERI for implementation during the period Jan 1, 1986 to Dec 31, 1988, the Members of the Governing Council at the meeting dated July 31, 1986 "desired to know the benefits that were accruing to the country or were planned to be achieved through various activities that were now being taken in hand by TERI. In order that a clear result orientation be maintained and the Members of the Council be informed of results actually achieved", the following decisions were taken:

- In each area of research a clear articulation of missions should be attempted by the research staff.
- An internal peer review of activities be carried out by a group of TERI staff to evaluate results achieved thus far and progress of work in specific areas of research.

In keeping with the decision of the Governing Council, the Director, TERI proposed the following actions:

- "Identification of Missions - Each area should identify clearly the specific missions that our

present and future activities are likely to achieve..... Area Convenors should assume the responsibility for submitting a draft of these missions before the end of Nov. 1986".

- "Peer Review Committee - Dr. T.N. Khoshoo has kindly agreed to chair the Peer Review Committee for evaluating the work done thus far area by area and to suggest changes in direction if any, and areas of emphasis, identification of strengths and weaknesses etc."

"The other members of this committee would be Dr.S. Ramesh, Dr.(Mrs.) Veena Joshi, Dr. Sunil Khanna, Dr. Ajay Mathur, Mrs. Leena Srivastava, Dr.(Miss) Arundhati Mukhopadhyay. The Committee would meet colleagues in individual areas and request for written material where necessary to evaluate the work that has been done thus far as well as to review and assess plans for the future".

The Committee, as per its terms of reference, looked into the work being carried out at TERI, met colleagues in various areas, and in light of these deliberations, has evaluated the direction of research being carried out at the Institute, identified problem areas, and suggested some changes.

The interrelated and interdependent sectors like energy, forestry and environment are today of vital importance to the country. These have, therefore, aroused considerable public attention. However, in the absence of authentic data, there is more fiction than fact being talked in media about these sectors. Many estimates, often at cross-purposes, float around. Equally important is the process of updating the knowledge of manpower involved in policy and planning particularly in the energy sector. Such major lacunae increase the importance as also the responsibility of the Tata Energy Research Institute.

2. CURRENT STATUS

The Tata Energy Research Institute (TERI) was registered as a non-profit organization in 1976 and was purely a sponsoring research institution till 1982 when Dr. R.K. Pachauri took over as Director and initiated inhouse research activities. The objectives were amended by the Governing Council of TERI at its meeting held on 3 August, 1985 which are now broad-based and not restricted to energy alone. Early projects taken up by the Institute were almost exclusively related to policy and planning issues, but the scope of activities considerably widened over the next four years as the number of staff members increased. The Institute made considerable progress in acquiring inhouse expertise and has built infrastructure for research and development, education and training and demonstration and extension. This has resulted in intensification and diversification of its activities. The areas of energy and biotechnololgy are its chief forte. The frontiers of both these are ever-widening.

Fifteen distinct areas of activity had been taken up by 1985-86, and at that time, in order to identify the critical needs of research and development in these areas, as well as to develop priorities and directions, a Three-Year Workplan was drawn up for the years 1986-1988. This review of TERI activities is being carried out when the first year of the Workplan is over. In a

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sense, therefore, it is too early to evaluate the quality and impact of the research that has been carried out thus far, but from another perspective, certain conclusions about the directions of research, the problems and constraints faced by TERI staff, and the future path of TERI itself can certainly be drawn.

TERI had a strength of 76 professional staff members as on January 31, 1987. This group is undoubtedly well-qualified, and one that has successfully demonstrated the capability to carry out multidisciplinary research. Appendix I gives a list of all the professional staff. The staff is young and dynamic and, given reasonable facilities and encouragement, would, no doubt, achieve the defined goals. Keeping in view the work already done and that proposed to be done, the Committee is convinced that TERI is on the march and has carved a place for itself at the national as also the regional/international levels. This is obvious from its involvement with international organisations like FAO, UNDP, UNIDO, UNU, UNEP, UNESCO, ICIMOD, UNICEF, World Bank, ILO, ESCAP, USAID, IDRC, APDC, QED; and at the national level with the central and state ministries, the Advisory Board on Energy and/or departments of Energy (including Electricity Boards), Non-Conventional Energy Sources, Coal, Petroleum, Environment and Forests, Agriculture, Rural Development, Biotechnology, Science and

Technology, Scientific and Industrial Research, Urban Development, Personnel Planning Commission, CAPART, Public Sector Undertakings (ONGC, NLC), industries etc., together with a number of subsidiary organisations/institutes under some of these departments. TERI also interacts with the university systems, Institutes of Technology and Management, as also with Non-Governmental Science Academies like Indian National Science Academy, Indian Academy of Sciences, National Academy of Sciences, and Indian Science Congress Association either directly or through its faculty. It also interacts with Solar Energy Society of India, Bio-energy Society of India, Indian Society of Tree Scientists and a host of other organisations. The Institute has taken the initiative to publish the Pacific Asia Journal of Energy (PAJE) with the Director, TERI, as the Managing Editor.

The prevailing expectation is that TERI, in time to come, would become a centre of excellence in research in the areas of energy and biotechnology; something of the standard of the Tata Institute of Fundamental Research or the Indian Institute of Science. In fact, most of the young professionals have joined TERI harbouring in their mind such an expectation.

Seventeen research areas are currently defined in TERI. They can be broadly classified into Policy and Planning (P&P) areas, Technology (Tech) areas and

Service areas. The Technology Area includes five sub-areas constituting the Biotechnology Group. This classification is by no means restrictive. Some Tech areas do carry out P&P work, while the future directions envisaged by some P&P areas involve technological developments as well. Descriptions of the missions and activities of these areas are provided below:

P & P Areas:

1. **Data Systems:** This group is involved in compiling energy and related data for various energy supply and demand sectors and subsectors. Data base files have been designed for hydrocarbon, coal and electricity sectors on the supply side, and agriculture, transport, industry, residential and rural energy sectors on the demand side. Annual time series data at the national level is also presently being compiled.

2. **Energy-Environment Interface:** This group is engaged in the study of the environmental impacts of fuel production and consumption at different stages and in different cycles, and suggesting mitigative measures to contain the ill effects. The group is studying the energy efficiency-pollutant emission factor tradeoffs in cookstoves, and is mathematically modelling the environmental impact of power plants. The group also

brings out a biannual publication, "Energy Environment Monitor", for the Department of Environment, Government of India.

3. **Energy Modelling and Intersectoral Analysis:** The group is working on developing energy economy models for India to assist the policy planning activities of the government. The group has developed an integrated model for the country as a whole, and is now looking at more specific sectoral and regional models. The group along with members of seven other groups is involved in a study examining the economic, technological and social choices available to India in the energy field with a focus on the year 2010 (TREND 2010).

4. **Fossil Fuels:** The mission of this group is to study the supply and utilization of fossil fuels with the goals of projecting recovery rates, identifying technologies for their recovery and utilization, and examining the policy issues stemming therefrom. The group is currently looking at the energy options for South India and at policy options regarding washing of non-coking coal for power plants. Mathematical modelling of Enhanced Oil Recovery techniques and of fluidized bed coal combustors are also under progress.

5. **Industrial Energy:** This group is engaged in characterizing the energy use in various industries and evaluating the techno-economic viability of selected

energy conservation technologies. The group has studied the energy use patterns in four different energy-intensive industries at the national level, and is currently carrying out a study on the efficiency of electric motors, and another on the potential of industrial cogeneration.

6. **Power Systems and Policy:** The group is carrying out policy oriented research with a view to improving efficiency in planning and operations in the power sector. Strategies for electric load levelling are currently being examined by the group, as are the alternative generation expansion strategies for the northern region, and options for rural electrification. A study of the Delhi load demand characteristics is also being carried out.

7. **Rural Energy Research and Extension:** The activities of this group straddle both P & P and Tech, as well as dissemination. The objectives of the group are to create an awareness of the energy problems, plan rural energy systems, identify and demonstrate energy efficient technologies, develop dissemination packages, and provide training for extension and monitoring. The group is working on developing two villages as models of rural energy management at the village level. Survey of villagers' needs and perceptions is being carried out, and the performance and acceptance of improved cookstoves and biogas plants is being monitored.

Additionally, the group is also evaluating the impact of the improved cookstoves programme of the Department of Non-Conventional Energy Sources, Government of India.

Tech Areas:

8. **Biogas:** The objective of this group is to examine the constraints in maximising production of biogas (methane) by a mixed bacterial culture using agricultural wastes as substrates. The group is presently engaged in identifying the bacteria from this mixed culture capable of degrading the substrate, and in the rate limiting steps in the utilization of agricultural wastes.

9. **Brassica and Stress Studies:** The objective of the group is to develop high-yielding varieties of the oil crop, Brassica. The group has adopted an integrated approach to achieve this objective, and is therefore presently attempting to develop cytoplasmic male sterile line (CMS). This is being attempted by using microspores of B.campestris or R.sativus carrying ClS cytoplasm and fertility restorer genes in the nucleus and fusing them with B.napus or B.juncea somatic cells. The group is also working on the identification of proteins involved with water stress and drought tolerance, isolation of RNA of protein which are specifically synthesized under water stress conditions, and possibility of using protein markers in segregating

progeny of the crosses between drought sensitive and drought tolerant types while selecting drought tolerant plants.

10. Cell and Protoplast Growth and Differentiation:

This group is concentrating on the basic physiological and biochemical studies of single cell growth and differentiation in Brassica juncea, and also plans to characterize and test the universality of the embryogenic factor(s) present in a conditioned medium that induces embryo differentiation.

11. Molecular Biology: This group is engaged in studying the nuclear and mitochondrial genome organization, identification of suitable genetic markers, and of DNA sequences responsible for CMS.

12. Tree Tissue Culture & Nitrogen Fixation Studies:

The group aims at evolving economic tissue culture techniques for cloning elite trees on a large scale, developing methodology for nodulating micropropagated elite clones of selected tree legumes, and transplanting the micropropagated plants on a mass scale. The group has chosen a number of species for study, and is currently developing micropropagation methods for them.

13. Chemical Energy: This group is engaged in developing a biogas-based Phosphoric Acid Fuel Cell (PAFC) for standalone electricity generation. A reformer for converting the methane-rich biogas to hydrogen-rich

feed has been fabricated. Electrode studies have been initiated, and a half cell for electrode evaluation has been constructed. A fuel cell for long-term tests has been designed. A 2.5 kW PAFC stack is being acquired for a demonstration pilot plant.

14. **Renewable Energy Technology:** The objectives of this group are to develop efficient and economic designs in solar thermal, wind and photovoltaic energy systems which are relevant to Indian conditions, and to monitor the performance of these systems in the field. The group is presently working on domestic hot water systems, solar cookers, passive architecture, photovoltaic system design and integration, biogas plant optimization, gasifiers, energy efficient bukharis, solar pond and drying.

15. **Social Forestry:** This group is developing methodologies for field testing the micropropagated plants raised by the Tree Tissue Culture group, and is also engaged in developing economically viable plantations, especially on degraded lands. Towards this latter end, work is in progress on studying growth rates of selected species in degraded lands, and multiplying and testing suitable clones for this purpose.

Service Areas:

16. **Computer Center:** The Center provides software support to users, and maintains the existing software and hardware. At the present time, the Center has seven personal computers and also maintains a direct access line to the Burroughs 6900 system at TCS.

17. **Information Services:** This area provides library and documentation services. The library has over 6000 volumes on energy and biotechnology related areas, and subscribes to 265 journals. The Documentation Center reviews current literature and provides bibliographic information on various subjects.

Detailed reports on each group describing their objectives and achievements, and the Committee's views of their constraints and future directions are provided in Appendix II.

The mix of projects taken up by the various groups in terms of relevance and time frame can be divided into short-term (less than 3 years), medium term (3-8 years), and long-term (more than 8 years). From this perspective, it is clear that evaluation of work has to be in the same time frame as the project. Thus, the projects taken up by the Biotechnology areas are all of medium or long term nature, as are those of the social forestry group and the chemical energy group. Some of the projects undertaken by the renewable energy

technology group (biomass gasifier, photovoltaic system development) are medium term projects. All the other projects are of short-term nature. Projects which have already been completed, and those which are short-term and currently in progress are listed below:

- Characteristics of cookstove performance
- Development of a Gaussian dispersion model for pollutants from a thermal power plant
- Development of a national integrated energy-economy model (TEESE)
- Development of a resource allocation model for energy
- Development of a rural energy model for village Dhanawas
- Energy Use Patterns in the Fertilizer, Brick, Aluminium and Zinc Industries
- Energy Conservation Studies of the Gujarat State Fertilizer Corporation and Indian Petrochemicals Limited
- Energy Audit of Synthetics and Chemicals, Bareilly
- Efficiency of electric motors in industry and agriculture
- Potential and Prospects of Industrial Cogeneration
- Development of model for oil production profile using Enhanced Oil Recovery techniques
- Development of model for Fluidized-bed Combustion of Indian coals

- Energy Options for South India
- Policy Options regarding washing of power coal
- Development of energy data base
- Pre-investment study for a Thermal Power Plant in Rajasthan
- Characteristics of DESU load demand
- Strategies for electricity load levelling in India
- Alternative electricity generation expansion strategies for the Northern region
- Options for rural electrification

The projects and their major findings have been described in various reports and research papers. All the publications have been internally and/or externally reviewed. A complete list of TERI publications is provided in Appendix III. The reviewing procedure has ensured the quality of research. It is also evident that the directions of research are well-planned and thought out. The development of the Three-Year Workplan was accompanied by debate regarding relevance and importance, and this has ensured both quality in the type of research being (and to be) performed at TERI, as well as individual participation and commitment to the selected projects.

The medium and long term projects largely address themselves to basic national problems. Comments on proposed future directions of some projects are

provided in the extended group descriptions in Appendix II.

At this juncture in the Institutes history, at the interface between a period of rapid expansion and a period of consolidation, it is also necessary to identify problems that could be major stumbling blocks in the path the Institute has charted for itself. These are addressed in the next section. Finally, we look at institutional measures that in the future, can both stimulate research within the organization, as well as project a strong image of TERI in national and international forums.

3. RECOMMENDATIONS

Problem Areas

The problems faced presently by TERI staff, and those anticipated in the future are of two types. The first is infrastructural: these are to a large extent being addressed already; we have tried to prioritize them. The second is related to institutional policies, or lack thereof.

Infrastructural Problems

1. **Space and Manpower:** Space is presently the most pressing and urgent problem. It affects research inasmuch as many projects (especially experimental) that cannot be taken up. It must be emphasized, however, that space is a medium-term problem, and would to a large extent be alleviated once the India Habitat Center (IHC) comes up. Meanwhile, space-intensive projects that do not need high-tech support can be given the go-ahead signal to move to Gwalpahari. Such projects include those taken up by the Social Forestry, Chemical Energy, RFRE and renewable energy technology groups.

The most pressing space need is that of the library. The physical presence of the books, back volumes of serials and anticipated future acquisitions demands space. An additional 20 sq.m. needs to be made available to the Library on a priority basis.

The next most urgent space need is that of the tech groups for lab space. The renewable energy technology and chemical energy groups continue to acquire equipment but have no space to set them up. The anticipated minimum lab space is 75 sq.m. Equally pressing is the need for at least two additional rooms for the Biotechnology group. An outdoor shed is needed for conducting R and D on biomass gasifiers.

Related to the question of space is that of manpower. Though several groups have identified it as a constraint, total manpower shortage seems to be only of 8 to 10 people. Adding on manpower, however, should be treated with caution since the manpower-project-space cycle can become endless. We would like to see a period of consolidation after the basic manpower needs are met with.

2. **Experimental Fields:** At Gwalpahari, area for the laboratory complex needs to be circumscribed immediately so as to use the remaining area for laying mid-term and long-term production trials of firewood plantations, provenances, Germ Plasm Collections, nurseries of the elite materials, etc.

3. **Equipment:** Most of the tech groups have acquired, or are in the process of acquiring, needed equipment. Discussion with individual groups brought out that the following equipment is to be purchased and/or fabricated

on a priority basis in order to ensure that the research programmes do not suffer: Glass houses, one each for Brassica and Tree Tissue Culture groups; Mist propagation facility for the Social Forestry group; 2.5 kW Phosphoric Acid Fuel Cell and a Gas Chromatograph for the Chemical Energy group; a computer for the Biotechnology division to take care of the needs of the Bioinformatics programme; Data loggers and portable monitoring equipments for field testing for the RERE group; Environmental Monitoring Instruments for the Energy-Environment group; software updating for DNA STAR and Gene Bank; and a mainframe computer for the renewable energy technology group.

The importance of these equipment cannot be overemphasized. Their acquisition, in a sense, constitutes the rate determining step in the activities of these groups.

4. **Secretarial Staff:** TERI is fortunate in having an excellent pool of secretarial staff. However, the previous months have seen a large turnover as an increasing number of secretaries leave to join the government despite better TERI payscales. The reasons seem to be better chances of promotion, and government housing. The Committee is not sure as to how this problem should be dealt with, but would like it to be taken up with a sense of urgency.

Policy Related Problems

5. **Inter-group linkages and interactions:** TERI has grown very fast, and currently there are seventeen defined research areas. While a few of these groups are interdisciplinary in nature, and cut across two or more areas, most of the research activity of groups is of a restricted and specialized nature. The problem of maintaining meaningful linkages between groups is of considerable importance to TERI's future growth. Internal seminars (in which every group presents their research work to all the professionals from time to time) are a useful beginning in this context, and should be further encouraged in a systematic manner.

6. **Sponsored Research:** The Institute has been promoting the external funding of research. This is, of course, desirable from both the institution's point of view, as well as for ensuring relevance of research projects. However, caution must be exercised that institutional goals do not get diluted because of the availability of external funding in other areas. Obviously, a tightrope has to be walked. At this point, in the Institute's development, the Committee does not want to specify the upper or lower limit of the level of external funding but only wishes to point out that a balance between relevance and innovation/ingenuity has to be maintained. A solution might be to internally review proposals before they are submitted to funding

agencies. These reviews would evaluate the proposal in terms of institutional aims and goals, national relevance and institutional commitments. The review process could be formalized by the setting up of a Research Committee with a broad-based membership. The process of internal discussion and consultation may also be followed for internally-funded projects.

7. **Training Programs:** TERI, as part of its mission, conducts several training programs every year in energy and related areas. These programs provide high visibility for TERI, and allow an indirect access into the energy policy and decision making processes at various level and in various organizations. There is, however, a feeling among TERI professionals that training programs are taking up too much time and effort. During 1986, 19 training programs were organized, and 10 are planned during 1987 (Appendix IV). The situation again calls for tightrope walking. We have to be very selective about the training programs we conduct; we should also look for some control in the selection of participants. The opinion of the professional staff (particularly those who would be involved) should be sought when deciding to take up a training program. This could be appropriately done by the Research Committee too. This would ensure greater and more meaningful involvement of TERI professionals in the chosen programmes.

Future Directions

The Institute has to keep moving towards excellence and relevance, and undoubtedly the accomplishment of the research goals the staff have made for themselves, will ensure this. Additionally, TERI should carve out a niche for itself in the public mind and in the scientific community. For this, a few high profile, high quality programs should be organized. Some suggestions are given below.

1. **Research:** Research at TERI has to be primarily applied development work based on sound basic research. It is this emphasis which will separate TERI from Universities and Institutes doing research in Energy and Biotechnology. The projects selected have to be vetted for social and economic relevance at the national level and due emphasis has to be placed on R&D appropriate for Indian conditions. In biotechnology areas, obviously, there has to be a strong component of pure research before any meaningful progress can be made on the applied front. However, the relevance of the basic research component to the applied end-uses must be kept in view.

There is also a strong correlation in TERI between the type of research activity carried out by a group (Tech or P&P) and the project time-frame (short, medium or long term). Thus, while projects carried out by P&P

groups are primarily of shorter duration (short or medium term), the opposite is true of tech groups. It is felt that P&P groups should also identify and take up at least one long term research project (consonant with their area mission). This will serve to anchor the research directions of each group which may otherwise shift emphasis from time to time depending on the nature of funded projects. Such long-term projects should not only look at P&P options for a particular problem, but should also look into general problems and methodology for P&P research in that area.

Other suggestions are given below:

Energy Environment Interface: The group needs to take up Environmental Impact Assessment of the hydro-power projects in order to evolve guidelines for formulation of the future projects. However, such studies can be taken only when adequate manpower becomes available.

Stress studies: These studies are important, but cannot be continued with subcritical inputs in the form of adequate manpower and space.

Tree Tissue Culture: Because of the availability of the field-testing facilities, the tree tissue culture group of TERI is in an advantageous position. To make use of these facilities, the group needs to concentrate on producing tissue-raised elite forest tree saplings of a

few chosen species so as to achieve meaningful results in a short time: the present list is rather long.

Social Forestry: Nutritional studies for forestry have not received sufficient attention in India. The availability of soil micro and macro elements, the amount of these removed from the soil by the plants, their concentrations in the soil for optimum biomass yield and the amounts required for replenishment require systematic study. The final yield will be limited if any one of these elements is limited. Deficiency of any of these elements can also increase susceptibility to diseases. The special nutritional requirements for rhizobia regarding cobalt, molybdenum and possibly nickel, should also be studied for biomass production from leguminous trees.

Information Services: The transfer of the Documentation Unit to TERI (New Delhi) from Bombay is a welcome addition. It would now have a major in-house back-up support of the professionals as also a good library. However, the number and nature of publications emanating from the Unit needs a careful re-examination. It may be better to bring down the number to a few chosen publications which are indeed relevant to the end-users.

2. **Annual Symposium:** An annual national/international symposium on a topic of relevance to energy or some aspects of biotechnology should be organized. The title

of the symposium should be chosen with thought and care, and participation should be by invitation only. The aim should be to help generate new ideas and thinking on a particular subject. In time to come, the community of scientists should look to the TERI symposia for new leads.

3. Publications: Five types of publications may emanate from TERI: a brochure describing the role and goals of TERI, an annual report containing progress made on various projects together with achievements, research papers on work done in TERI, proceedings of the annual symposium, and publications emanating from the documentation center.

The brochure and the annual report should be widely disseminated, and should meticulously project TERI's image as a non-profit scientific and technical institution engaged in research, development, training, demonstration and extension. This is necessary because TERI is confused with TCS in some circles.

The Committee found that many of the research and discussion papers/reports/reviews prepared in TERI are indeed excellent. They often contain very valuable data, critical analyses and new ideas. Sometimes, even the approach is innovative. All this material must go out of the confines of TERI and be exposed to the experts in the field. Firstly, these may be abridged

and published in national/international journals of repute. This is already being done, but needs to be accelerated. Also, TERI may think in terms of publishing an annual volume, with an appropriate name, containing chosen research or discussion papers/reviews/reports. Such a volume should be a priced publication. We could negotiate with a national publisher (with international links) for publication of such a volume each year, and the extent and nature of royalty settled. As long as excellence is the hallmark of such a publication, one can be sure that people all over the world will look expectantly for such a publication, as we do for some of the annual series in our own specialities brought out by publishers like Academic Press.

The proceedings of the Annual Symposium should also be brought out through some good publisher who has links abroad so that it can be properly disseminated.

4. **Administrative pattern:** One of the major reasons for the success of TERI in such short time has been the absence of governmental culture in its functioning. While everyone in TERI should be accountable, the ante-dated rule-ridden governmental approach must be avoided at all costs.

APPENDIX I: LIST OF TERI PROFESSIONAL STAFF

Director

1. Dr. R.K. Pachauri

Distinguished Scientist (CSIR)

2. Dr. T.N. Khoshoo

Head, Biotechnology

3. Dr. V. Jagannathan

Senior Fellows

4. Mr. A.N. Chaturvedi
5. Dr. S. Ramesh

Fellows

6. Dr. Dilip R. Ahuja
7. Dr. Ashok Gadgil
8. Dr. Veena Joshi
9. Dr. Sunil Khanna
10. Dr. V.V.N. Kishore
11. Dr. V.S. Kothari
12. Dr. (Mrs.) Malathi S. Lakshmikumaran
13. Dr. J.D. Pandya
14. Dr. Deepak Pental
15. Mr. G. Sambasivan
16. Mr. P.V. Sridharan

Research Associates

17. Mr. Alok Adholeya
18. Ms. Abha Agnihotri
19. Ms. Gopika Bhagat
20. Mr. Ranjan Bose
21. Mr. G.S. Cheema
22. Mr. Sunando Dasgupta
23. Dr. Vibha Dhawan
24. Mr. Pradeep K. Dutta
25. Ms. Charu Puri
26. Mr. Kalyan Kumar Ghosh
27. Dr. Anil Grover
28. Ms. Sujata Gupta
29. Ms. Vibha Gupta
30. Mr. Harish Hanagudu
31. Mr. Jami Hossain
32. Ms. Kavita Johry
33. Mr. M. Karuppasamy
34. Mr. Sunil Katam
35. Ms. Bindu Kaul
36. Ms. Sangeeta Kohli
37. Mr. Ashok Kumar Luhar
38. Mr. Rajeev Maini (VRA)
39. Dr. K. Manoharan
40. Dr. Ajay Mathur
41. Dr. Syed Moinbasha
42. Mr. Sanjeev Mukerjee
43. Dr. Arundhati Mukhopadhyay

44. Ms. Hema Narayanan
45. Dr. Bhaskar Natarajan
46. Dr. Akshay Kumar Pradhan
47. Mr. Shirish Anand Ranade
48. Mr. Sanjay K. Rastogi
49. Mr. Satish Chander Sabharwal
50. Mr. P.M. Sadaphal
51. Ms. Neela Srivasan
52. Ms. Leena Srivastava
53. Mr. Sudeep Kr. Srivastava
54. Mr. Thangaraju
55. Mr. Kapil Thukral

Research Assistants

56. Mr. Braj Nath Mishra
57. Mr. Ramchandra Pal
58. Mr. P. Raman
59. Mr. V.V. Ranga Rao
60. Mr. Arvinder Singh

Technical Assistants

61. Mr. Anoop Kumar Sharma
62. Mr. B.S. Yadav

Programming Assistants/Data Entry Assistants

63. Mr. Ravi Iyer
64. Mr. T. Radhakrishnan
65. Ms. D. Ramelashanthi
66. Mr. T. Ramesh

Library Services

- 67. Ms. Nivedita - Co-ordinator
- 68. Ms. Daksha Vaja - Librarian
- 69. Mr. Anil Kumar Verma - Assistant Librarian
- 70. Ms. Bharati Paliwal - Information Analyst
- 71. Ms. Idrissa Pandit - Mr. Debal Chandra Kar
- 72. Mr. Debal Chandra Kar - Library Assistant

Documentation And Information Centre

- 73. Ms. V. Vijayalekshmi - Information Analyst
- 74. Mr. Arup Roy Chaudhury - Information Analyst
- 75. Mr. M.C. Shukla - Information Analyst
- 76. Mr. M.R. Surendran - Data Entry Operator
- 74. Mr. A.B. Jadhav - Library Attendant

APPENDIX II: DETAILED DESCRIPTION OF SUBJECT AREAS:
OBJECTIVES, ACHIEVEMENTS, CONSTRAINTS
AND FUTURE DIRECTIONS

POLICY & PLANNING GROUPS

1. DATA SYSTEM

As indicated in the Three Year Work Plan, the Group is now in the process of compiling energy and related data for various energy supply and demand sectors and sub-sectors. This is a logical step ahead from the present situation, when data related to various energy and other economic sectors are widely scattered in different institutions and are not readily available to researchers and policy makers.

Achievements

- The data base file structures have been designed for:
(a) hydrocarbon, coal and electricity sectors on the supply side and (b) agriculture, transport, industry, residential and rural energy sectors on the demand side;
- To a substantial degree, annual time series data at the national level have been compiled, entered and edited. There have been some slippages in this phase of work, for reasons explained below;
- Data retrieval systems have been designed for four of the sectors mentioned above; and

- The first of a series of annual publications on Energy and Related Data titled TERI Energy Data Directory and Yearbook (TEDDY) has been brought out in February 1987. This is only a beginning and we hope to improve it substantially next year and beyond.

Constraints

- The Group is essentially at the mercy of the Pragati Computer, which has an unusually high down-time;
- The data base design was started when TERI had only dBASE-II. Consequently, all work has been done on dBASE-II, which imposed certain restrictions on data base file design. We would like to shift to dBASE-III as soon as the present phase of work is completed - most likely by April 1987; and
- The group has not been able to acquire the services of a reliable and experienced data entry operator. The first data entry operator was assigned to the Group in July 1986. However, on checking the data in September 1986, several errors were discovered. As a result, from October to early January, no new data were entered, but the Group was engaged only in data validation and editing. The new data entry operator is in the process of picking up the work.

Future Directions

- To complete the data base for time-series data at the national level;
- To compile and enter data at the regional/state level. The file designs are such that state level data can be integrated within the framework of the national level data;
- Also to have a data base which covers trends, growth rates and other derived data indicators, for each of the economic sectors;
- To prepare a "User Manual" which will facilitate the work of data base users; and
- To bring out annually, a publication which summarizes the data collected in-house in TERI.

2. ENERGY ENVIRONMENT INTERFACE

One of the major causes of the environmental degradation in India is the result of increased fuel consumption (be it fossil, biomass, etc.) without proper mitigative measures. This Group is engaged in a study of the environmental impacts of the fuel consumption at different stages and in different cycles including hydro-electric and of mitigative measures to contain the ill-effects. This Group also brings out a half-yearly publication called Energy - Environment Monitor (EEM) for the Environmental Information Service of GOI.

Besides ENVIS, there are four projects in progress. These are : Research on Environmental Impact of Thermal Power Stations, Cook Stove Programme, Water Quality Management in the Ganga, and Urban Air Pollution Studies. Work is in progress on all these within the constraints of availability of staff.

Achievements

- Following conclusions have emerged from the project on cook stoves:
 - Emission factors for CO and TSP increase with increasing efficiency.
 - Emission factors are higher for crop residues and dung cakes for all stoves as compared to those for fuelwood.
 - A Performance Index has been developed to rank order the stoves.
- Publication of Energy- Environment Monitor meets the information needs of this newly emerging activity.
- Interaction and discussion in the workshop in Environmental Management of Thermal Power Stations has led to a study of desulpharization technologies for abatement of SO₂.
- Development of computerized Gaussian Dispersion Model.
- Pollution Control Handbook (Utililty Publishers) contains contributions on the state of our knowledge on Domestic Pollution and Power Industry.

Constraints

- Lack of suitable manpower (eg. for studying the Environmental aspects of Hydroelectric Project).
- Delays in instrument procurement.
- Delays by funding agencies in their decision making on the proposals submitted by TERI.

Future Directions

- Technology assessment of options to reduce sulphur emission from coal-fired power stations in India.
- Emissions from energy processes in Delhi. Measurements and predictions of emissions of air pollutants from energy processes in the Delhi region. Based on such information an interactive regional and computerised model can be constructed for developing countries.
- Data Bank for Thermal Power Stations.
- Integrated ecological studies regarding hydro-electric projects.
- Raising Energy-Environment Monitor to the level of a professional journal.
- Development of laboratory capabilities for Measurement of concentrations and Emissions resulting from Combustion Processes.

3. ENERGY MODELLING AND INTERSECTORAL ANALYSIS

This Group was initially set-up to meet a felt need for an integrated energy model for the country as a whole. As a result of this the Group developed The TERI Energy Economy Simulation and Evaluation Model (TEESE) which has been adopted by the Advisory Board on Energy as the Energy Model for India. Integrated energy modelling provided the main thrust for the group but it has now expanded its areas of activity to look at more specific sectoral and regional models. Deserving special mention is the project christened as TERI's Research on Energy in National Development upto 2010 (TREND 2010) in which eight groups are working closely to project energy demands and supply to the year 2010 keeping in mind various economic, technological and social choices available. The study would examine in quantitative terms the sensibility of the total system to several policy options concerning interfuel substitutions, investments, resource requirements, costs and so on.

While the above aims and objectives are broadly the same as that given in the Three Year Work-Plan the jobs proposed to be undertaken include in addition to those stated in the Three Year Work-Plan the following;

- A literature review on Energy Environment Models with particular reference to Forestry Models and Pollution Dispersion Models.

- Development of an industry process model (Cement).
- Development of an urban energy model.
- Expansion of the TEESE Model.
- The development of a goal programming approach to modelling Biomass resources.
- Expansion and refinement of the model on Resource Allocation for Energy.
- Development of a rural electrification model.

Achievements

As far as modeling is concerned three major areas of activity were initiated and partly completed (as the modeling activity is an on-going activity):

- A National Level Energy Economy Model for India (TEESE Model)
- A Resource Allocation Model for Energy
- The Rural Energy Model for village Dhanawas

The TERI Energy Economy Simulation and Evaluation Model (TEESE) has now been developed for the base year 1984-85 under the sponsorship of the Advisory Board on Energy. This model can be termed as a major achievement as it will be used for policy making purposes by the planning organisations in the country. Of immediate importance just now is for us to carry out scenario analysis with the TEESE Model in order to provide inputs for the mid term appraisal for the Seventh Five Year Plan.

The resource allocation for energy model though highly aggregated can be said to be a satisfactory model in-so-far as it was very well received in two training programmes (on Energy Planning in developing countries) held in Nepal and Bangladesh. This model would of course need to be developed much further and we propose to do that in the following 2-3 years.

On the inter-sectoral analysis part the following major studies were completed:

- Transfer of Energy Technology from the United States to India
- Food Energy Nexus in India
- Impact of Price and Non-price Policies on Energy Demand Management
- Economic Evaluation of Natural Gas Utilisation Options

Constraints

- Insufficient allocation of professional time to this activity
- Access to computers and software.

Future Directions

The following areas of activity have been identified by the Energy Modeling and Inter-Sectoral Analysis Group for the next 2-3 years.

- A literature review on Energy Environment Models with particular reference to Forestry Models and Pollution Dispersion Models. Following this review we may identify further areas of work on the above two subjects.
- Development of an industry process model - It has been decided that one energy intensive industry (Cement) would be studied in detail and a model would be developed for this industry taking into account the different technologies/processes which are being utilised by this industry. This model would be used for forecasting energy demand, for estimating the optimal mix of energy and also for providing guidelines to the manner and rate at which any technology/process can be substituted for an existing technology/process.
- Development of an urban energy model - This model would study the entire energy flow in an urban area (perhaps Delhi) taking into account energy consumption in all sectors. The environmental aspect will also be covered in this study.
- Expansion of the TEESE Model to include energy demands by various income groups in the urban and rural sectors as well as transportation energy demand by distance of movement. Scenario analysis with the help of this model for planning purposes.
- The development of a goal programming approach to modeling rural systems by taking into account various

trade offs relating to the food fuel and fodder sectors, land distribution patterns, land tenure systems, income classes etc.

- Expansion and refinement of the resource allocation for energy model.
- Development of a rural electrification model for a cluster of villages.

4. FOSSIL ENERGY

The Three Year Plan envisages work on three fossil fuels: oil, natural gas and coal. The emphasis would be to study new technologies for utilisation of coal and fluidized combustion systems. TERI is to disseminate such information to the Indian industries by publishing an Annual Newsletter beginning from 1987. Furthermore, the issues regarding hydrocarbon supply would be examined as also the use of enhanced oil recovery techniques.

The Group has taken up only two areas i.e. coal and oil. In coal, three projects identified in the Workplan have been modified so as to include both conventional and advanced coal utilisation technologies. Projects have been prepared for submission to Department of Coal (GOI). A project, "Study of energy options for South India with special reference to power generation and lignite deposits", has been taken up. An approach paper on "Policy options

regarding washing of non-coking coal supplied to thermal power plants" has been prepared and submitted to the Department of Coal. Preliminary work on fluidized beds as high temperature furnaces has been carried out. A proposal for the modelling of fluidized-bed combustors burning Indian coals is to be submitted to the Department of Science & Technology.

Two project proposals in oil were prepared and submitted one each to ONGC and Planning Commission. The former has since sanctioned the project on Enhanced Oil Recovery (EOR) Techniques for Hydrocarbon Reserve Development. Mathematical modelling of the production profile using EOR has been completed.

Achievements

- Two projects, one each in coal and oil sectors sponsored by M/s NLC Ltd. and M/s ONGC respectively, were taken up for study during the later half of 1986.
- An approach paper on Beneficiation of Non-coking coal for Power plants was presented at the Jaipur Workshop on "Energy Policy Issues". It was decided that further study on techno-economics of washing should be carried out for a policy decision.

Constraints

- Changes in the composition of the Group.
- Delay caused by the external agencies in communicating their decision on the projects submitted by TERI.
- Lack of sufficient staff; there is immediate need for one Research Associate for the coal work.
- Computing facilities though adequate at present, would need substantially large storage facilities on account of the Group being essentially involved in policy and modelling.

Future Directions

- Development of costing models for coal production technologies.
- Techno-economic study on beneficiation of non-coking coal for power plants for more efficient use of coal resources.
- Modelling of Fluidized bed coal combustors.
- Computerisation of the mathematical model of the production profile using EOR techniques.

5. INDUSTRIAL ENERGY EFFICIENCY

The Industrial Energy Efficiency group has been currently working on the following projects: Energy Use in (1) Fertilizer, (2) Aluminium, (3) Brick, and (4) Zinc Industries; Energy Conservation Case Study: (5) Gujarat State Fertilizer Corporation, and (6) Indian Petrochemicals Corporation Ltd.; (7) Energy Audit of Synthetics & Chemicals Ltd. , Bareilly, (8) Efficiency of Electric Motors, (9) Development of Industrial Energy Data Base and (10) Industrial Cogeneration Study.

The project on energy use in the brick industry is funded by IDRC, and the energy audit of S & C, Bareilly, is sponsored by that company itself. In addition, the project on electric motors efficiency will likely be funded by CEA. All the other projects are TERI funded.

The second and fifth projects have been completed.

The first, third, fourth, sixth and seventh projects have been mostly completed. The final report of the first project is being written and will be ready by the middle of April, 1987. The draft report of the sixth project has been completed and this is being reviewed. The final report should be ready by June 30, 1987.

The final report (draft) on the energy audit at S & C, Bareilly, was completed in February 1987. The

final report on this energy audit is expected to be issued by May 31, 1987.

Work has been initiated on the eighth project, though the funding has yet to be received.

The remaining three projects have also been started.

Achievements

- Technology Assessment Studies
 - Computer program for analysis of cogeneration systems has been developed. Final draft report expected to be issued by end of May, 1987.
 - Proposal for a comprehensive study of industrial electric motors was submitted to CEA.
- Engineering-Oriented Activities
 - Interim report on the energy audit of the Synthetics and Chemicals SBR plant at Bareilly was issued in October 1986. Final report (draft) was in preparation at the end of the year. This was issued to S & C in the first week of February, 1987.
- Data Bases
 - Data base for the electricity use in industry in India based on the CEA data has been created. Review and finalisation of data to be completed by end of April 1987.
 - Data bases for aluminium, zinc, fertilizer and

brick industries have been completed. Draft reports have been issued. Final version of aluminium report was issued in December 1986. Other reports are expected to be finalised by end of June 1987.

- Information Dissemination and Training
 - Case studies: Draft reports (2) on case studies of the Gujarat State Fertilizer Company Ltd. and IPCL have been completed. Final report for GSFC case study will be completed by end of April 1987 and the latter by June 30, 1987.

Constraints

- Lack of manpower, difficulties in data collection and frequent additions of small jobs.
- The USAID study required 6 manmonths of effort, which was not accounted for when the Work Plan, 1986-88 was prepared.
- Two additional experienced mechanical or chemical engineers or Operations Research Personnel are needed (Research Associate).

6. POWER SYSTEMS AND POLICY

The Power Systems Group is engaged in "policy-oriented research with a view to improve planning and efficiency in operations in the power sector". The on-going projects of the group are in accordance with these

objectives. The present projects are :

Two Strategies for Electric Load Levelling for India:
This has been sponsored and funded by the Advisory Board on Energy. Phase-I deals with energy-efficient lighting systems, and consequent reduction in peak (lighting) loads with specific emphasis on Bombay; however, in the study, there are possible policy lessons for the urban areas in the country as a whole. This report is almost ready and will be sent to the ABE shortly.

Phase-II of the study concerns possible economies resulting from the introduction of time zones in the country. The approach paper has been finalised and initial work relating to survey in four parts of the country has started. Extensive data collection has been carried out and work is in progress. Owing to data limitations and manpower constraints, Phase-I of the study has been delayed.

Study of the Characteristics of the DESU Load Demand:
This study, funded by the Delhi Electric Supply Undertaking, is in three modules. Module-I Report has been submitted to DESU. Work on Modules II and III is in progress.

Alternative Generation Expansion Strategies for the Northern Region: This project is funded by the Advisory Board on Energy. The objective of the study is to examine the alternative strategies for meeting the

projected peak and energy demand at the lowest cost to the economy in the short and medium time-frames. An interesting feature of this study is the specific inclusion of captive generation as an option for investment planning. A field survey of captive power units in Haryana, Uttar Pradesh and Rajasthan has already been initiated. The project is on schedule.

Rural Electrification: This involves a study of alternative options in the rural electrification sector with a view to determine future policies on rural electrification and the role of renewable energy technologies. The study is at an initial stage.

Apart from the above projects, the group had earlier completed a pre-investment study report on thermal power stations in Rajasthan in 1984.

Members of the group are also involved as faculty members in other training programmes on energy planning, etc.

As can be observed, the group has attracted funding support from many agencies.

Achievements

- "Pre-investment Study for a Thermal Power Station in Rajasthan", submitted to the Rajasthan State Industrial Development and Investment Corporation Limited.

- A study of the characteristics of DESU Load Demand", submitted to the Delhi Electric Supply Undertaking.
- "Two Strategies for Electric Load Levelling in India", submitted to the Advisory Board on Energy, Government of India.

In addition, several papers on various policy-related issues have been written by members of the group.

Constraints

- Inadequate availability of computer time.
- Computer software.
- Professional staff for projects.

Future Directions

The group plans to continue its involvement in policy-oriented studies in the power sector. A project on electricity costs and tariffs for the Tamil Nadu Electricity Board has been initiated this year. This study is expected to have a direct impact on future tariffs in Tamil Nadu as such, it brings the group closer to actual implementation of suggested policies. It is expected that projects to be undertaken in the future will continue to have this emphasis.

7. RURAL ENERGY RESEARCH AND EXTENSION

In the Indian context rural energy needs are indeed very important because about 76% of the population is in rural areas and very little attention has been paid to their energy needs. The Three Year Programme underwent significant changes during 1986. The approach is essentially sound and six activities identified are: Rural energy surveys; Creating awareness about energy problems; Technology Demonstration; Development of dissemination packages; Rural Energy Planning; and Training, Extension and Monitoring. Each of these have been sufficiently paraphrased keeping in view the experience gained so far. The major problem is to bring in realism and precision in these studies. These would be funded by UPSEB, Haryana Government, UNESCO and TERI.

Achievements

- Development of an approach to carry out activities in rural energy research and extension.
- Development of a survey methodology for the collection of rural energy data and annual survey in three villages of U.P. and two villages of Haryana.
- Mathematical structure for rural energy model.
- Demonstration of Biogas, improved woodstoves, solar cookers and solar water heaters in Dhanawas.

Constraints

- Manpower for extension activities.
- Availability of cost effective technologies.
- Low level of awareness about energy problems.

Future Directions

- Developing Berka-Ali-Muddin and Dhanwas as models for rural energy management at village level.
- Developing norms for the study of rural energy systems.
- Development of methodology for dissemination.
- Generating typologies through rural energy studies.

TECHNOLOGY GROUPS

BIOTECHNOLOGY

8. BIOGAS

The project on microbiology of biogas proposes to examine the constraints in the enhanced production of methane (biogas) by a mixed bacterial culture using agricultural wastes as substrates. Methane production can be increased by identifying the rate limiting steps in the utilization of agricultural wastes. In addition, it would be necessary to establish the structure and mechanism of expression of methanogenic genes and to apply this knowledge to the manipulation of genes which encode enzymes directly involved in methane biogenesis.

Achievements

- The generation of methane from agricultural waste viz. rice, wheat and sorgham straw has been successfully done.
- Developed mixed cultures capable of degrading rice, wheat and sorgham straw. These cultures are being stabilized and also the upscaling of the digester from 4 litres to 10 litres has been done.
- Various groups of bacteria viz. cellulose degrading, acid producing and methane producing have been isolated and purified.
- Identification of these various bacteria is in progress.

Future Plans

- Identification of the various bacteria isolated from the mixed culture capable of degrading agricultural wastes.
- Detection and quantification of methanogens and cellulose degrading bacteria using the immunological technique of ELISA.
- Studying the metabolism of the various groups of bacteria to identify the rate limiting step in methane biogenesis. This shall require the elucidation of the biochemical steps in the utilization of the agricultural wastes and their regulation.

- Identification of the regulatory steps and purification of the various enzymes involved in these steps. These enzymes will be then used as probes for identifying and isolating genes using in vitro genetic engineering techniques. The aim would be to introduce this genetic information with the help of multicopy plasmid vector into a bacterium which would be thus capable of performing these enzymatic reactions at an enhanced rate.

9. BRASSICA AND STRESS STUDIES

In accordance to the Three Year Plan evolved during early 1986, the Group is to develop high-yielding varieties of oil-seed mustard Brassica Juncea.

The main task of the group is to produce cytoplasmic male sterile (CMS) lines of Brassica juncea using techniques of somatic cell hybridization and genetic transformation. CMS and Restorer lines thus produced would be provided to the agricultural institutes for development of hybrid seed technology. If proper facilities are developed, TERI could also be involved in the breeding aspects.

To transfer the character of male sterility from radish (Raphanus sativus) to mustard (Brassica juncea) the following activities will have to be undertaken.

- Regeneration from protoplast/cell/callus cultures of

Brassica juncea.

- Introduction of genetic markers through Agrobacterium based vectors into radish which is going to be used in somatic hybridisation experiments.
- Combining mitochondrial CMS genes with fertility restorer nuclear genes in radish through somatic/conventional hybridization.
- Synthesis of triploids through fusion of microspore protoplasts of radish with somatic cell protoplasts of B. Juncea. Synthesized allotriploids will be used for selecting male sterile lines, restorer lines and lines with mitochondrial recombinants.

Achievements

- Isolation and culture of protoplasts of B. juncea and B. napus.
- Regeneration from leaf discs of B. juncea (two varieties). This is a necessary prelude to genetic transformation of those species with Agrobacterium based vectors. Similar regeneration system will be developed for CMS radish.

Future Directions

- The scheme of synthesizing allotriploids by protoplast fusion will be tested on Nicotiana species to train scientists working on Brassica project in some of the methods of protoplast fusion, selection

and genetic characterization. This will also help in establishing and streamlining various techniques under Indian conditions.

- Protoplast culture and plant regeneration systems will be optimized for B. juncea and B. napus.
- Crosses will be made between R. sativus CMS and R. sativus lines with restorer genes to produce R. sativus plants for fusion with B. juncea.
- Selected Brassica types will be transformed by Agrobacterium mediated vectors for introducing drug resistant marker genes. This will help in the selection of hybrid cells and plants.
- The biochemical and molecular techniques for characterization of transformed plants and somatic hybrids will be established.

Constraints

- The group feels that in order to maintain an even pace of work round the years, using crops which are essentially grown in winter, they require a minimum of two walk-in growth chambers, and a green house and auxiliary power generator.
- Addition of one professional and a gardener (towards the end of 1987) is also essential to keep up the schedule.

STRESS STUDIES

Research on stress studies is essentially basic in nature. Water stress is one of the major reason for low yields of rice in Eastern India. The main objectives of the study are:

- Identification of proteins invoved with water stress in rice (Oryza sativa).
- Exploration of the possibility of using protein markers in selecting for drought tolerant plants in segregating progeny of the crosses between drought sensitive and drought tolerant types.

Achievements

- The germplasm of resistant and susceptible varieties of rice have been identified and procured from the International Rice Research Institute.
- Two dimensional gel electrophoresis method for analysing the protein profile has been standardized.

Constraints

- Lack of growth chamber to raise plants.
- Addition of one Technical Assistant is necessary as raising and maintaining the experimental plants is labour intensive.
- The group also feels that avallability of more work-space in the lab which at present is being shared

with Molecular Biology Group, will help to increase the working efficiency.

10. CELL AND PROTOPLAST GROWTH AND DIFFERENTIATION

The complexity of the biological material and the poor understanding of the physiological and biochemical implications of regeneration process has rendered this science absolutely empirical and consequently success uncertain. Emphasis is, therefore, laid on initiating investigations on these aspects. The objectives are:

- To find suitable media condition/composition able to support growth and differentiation of single cells or cells plated at low density.
- To characterize new growth factors, if any, in such complete media.
- To search for and identify factor(s) inducing embryogenesis.

Achievements

- Developed protocol for somatic embryogenesis in B. nigra.

Future Directions

- To determine the new factors required for such cell growth. The use of these new media for protoplast growth will also be studied.

- Somatic embryogenesis of Brassica will be studied in detail and the suitability of the methods for other species will be examined.

Constraints

- In addition to the general constraints such as lack of growth chamber facility and power shortages, this group also emphasized the need for streamlining the library facility.

11. MOLECULAR BIOLOGY

Little information is available on the genome organization of plants. The characterization of the repetitive and unique DNA, sequences responsible for gene expression and regulation, and identification of genes of agronomic importance are valuable for genetic engineering. Another important area of research is the identification of suitable genetic markers in plants. This is useful for plant breeding programmes and genetic manipulation of plants. The main objectives are:

- Nuclear and mitochondrial genome organization;
- Identification of suitable genetic markers by restriction fragment length polymorphism; and
- Identification of DNA sequences associated with cytoplasmic male sterility.

The work will be carried out mainly in Brassica and rice. The former is of importance because of shortage of edible oil and the latter is the major crop in South Asia.

Achievements

- Establishment of laboratory facilities.
- Isolated and purified total DNA from Brassica species.
- The genomic DNA was digested with restriction endonucleases viz. Bam HI, Sal I, Hind III, Eco RI and Alu I. The restriction patterns were blotted to nitrocellulose paper for hybridization work. This work (hybridization) started after we received radio isotopes from BARC.
- The satellite DNA sequences and some dispersed repetitive DNA sequences have been identified.
- The isolation and characterization of these sequences are being carried out.

Future Directions

- Identification of repetitive DNA and cloning in suitable vectors.
- Characterization of repeated DNA sequence differences within and between Brassica genomes, i.e. sequencing of repeat DNA clones and chromosomal distribution.
- Construction of recombinant DNA library of B. campestris genome.

- Identification of suitable specific sequences to be used as probes for restriction fragment length polymorphism.
- Isolation of mitochondrial DNA of Brassica and restriction enzyme analysis.
- Comparison of restriction patterns of different Brassica varieties and typing of the mitochondrial genome.
- Identification of DNA sequences associated with cytoplasmic male sterility in Brassica.

Constraints

- Work to be carried out in characterization of Rice genome is very competitive. If additional manpower is available, these studies can be initiated. As it is, with existing manpower, only the Brassica genome characterization is being carried out. The work is, however, exhaustive.
- The second major constraint is insufficient workspace especially for growing and maintaining our plant systems and for carrying out cloning experiments, which at present are being done at 7 Jor Bagh using the microbiology facilities.
- Thirdly, routine requirements of glass double distilled water and ethanol for all DNA precipitations are at present very inadequate.

12. TREE TISSUE CULTURE AND NITROGEN FIXATION STUDIES

The species selected are: Leucaena leucocephala, Leucaena hybrids L. Ougeinia dalbergioides, Pongamia pinnata, Prosopis juliflora, Populus sp., and bamboos.

The research activities will involve:

Objectives

- Evolving economic tissue culture technique for cloning elite trees on large scale.
- Establishing germplasm collection of the rhizobial/mycorrhizal strains to select the efficient ones.
- Developing methodology for nodulating micropropagated elite clones of selected tree legumes. The factors affecting enhanced symbiosis as well as increasing nitrogenase activity would also be studied.
- Transplanting micropropagated (and nodulated in case of legumes) plants to the field on mass scale.
- Field testing of the plants for clonal uniformity and its comparison with the seed raised population.

Achievements

- Methodology has been developed for micropropagation of Leucaena leucocephala and semi-sterile hybrid of L. leucocephala x L. pulverulenta and mature selected trees of Populus sp.
- The rhizobia/mycorrhiza has been isolated from the

indigenous soils and also collected from the groups working abroad for the selected species.

- The nodulation of micropropagated Leucaena leucocephala plants have been achieved and designs for the field trials of test-tube plants has been made.
- In vitro associations of mycorrhizae with micropropagated poplar clones have been established.

Constraints

- Limited space.
- Lack of green house, forcing us to design our experiments according to season.

Future Directions

- Developing micropropagation methods for seedling and adult trees of Leucaena leucocephala hybrids, Ougeinia dalbergioides, Pongamia pinnata, Prosopis juliflora, Sesbania grandiflora Populus sp. and bamboos.
- For tree legumes, efficient strain of Rhizobium will be selected with seed material and that will be applied for nodulating micropropagated plants. Mycorrhizal strains for the selected species will be tested for infection and other beneficial effects. For non-leguminous trees, highly effective mycorrhizal association will be selected and propagated.

- Large scale transplantation of micropropagated plants and evaluating them for:
 - Clonal uniformity
 - Gain over seed raised plantation in terms of biomass.
 - Soil improvement over a period of time.
 - Protocols for protoplast isolation, culture, regeneration and genetic transformation with a view to developing pest resistance will be established.

13. CHEMICAL ENERGY

This Group identified the development of fuel cell technology as its objective in the Three Year Plan. Fuel Cells have an enormous potential as stand alone electricity generating units using locally available renewable or non-renewable sources of energy. In this perspective, the group developed four projects, namely:

1. Fuel Cell Application in India: A Case Study
2. Evaluation of Fuel Cell Electrodes
3. Development of an experimental Fuel Cell for electrode kinetic studies
4. Systems design, engineering and demonstration of Phosphoric Acid Fuel Cell

The first project was supported by UNESCO and has been successfully completed. It was shown that various

conventional and non-conventional fuels such as natural gas and biomass derived fuels like biogas offer interesting possibilities of employing small sized (10-200 kW) phosphoric acid fuel cells (PAFC) for decentralized power generation. The finding also revealed that the economics of electricity generation from fuel cell-biogas system would be comparable to the cost of supply from centralized grid system and more competitive than photovoltaic option. The report was presented at an International fuel cell workshop organized by UNESCO and resulted in TERI becoming a part of an international network for fuel cell technology transfer and cooperative research activities.

The second and third projects were together submitted as a proposal to DIES and funding of Rs. 11.15 lakhs has now been received. A half-cell for Phosphoric Acid Fuel Cell electrode characterization has been designed and fabricated in consultation with the Johnson-Matthey Research Centre (JMRC), UK, under a collaborative research scheme. The Wenking Potentiostat, digital multimeters and other instruments required in this study have been procured. Some test electrodes have also been acquired from JMRC. The design of the experimental fuel cell to be developed under the third project has been completed. The materials and instruments required for its fabrication have been identified.

The fourth project involves the development of a suitable processes to remove impurities such as H_2S from the biogas and subsequently reform it to produce H_2 rich gas for a PAFC. A lab-scale biogas reformer has been designed and is presently being set up in IIT, Delhi. Negotiations for a 2.5-5 kW fuel cell with a Japanese and an American manufacturer are currently going on. The project funding of Rs. 9.79 lakhs has been procured from DNES.

The Group feels that its activities and progress are restricted due to lack of lab space, as well as inadequate administrative and material inputs. In spite of constraints, all the four projects are still proceeding according to the schedule of activities in the Three-Year Workplan. The lab plans have been substantially delayed, and the Group feels that any further delays will cause the programme to fall behind schedule.

Achievements

- Established a computerized data base on fuel cells technology and prepared a comprehensive state of the art report.
- Convened a national workshop on fuel cells and submitted recommendations for national level integrated fuel cell programme to the Department of Non-

Conventional Energy Sources, Ministry of Energy, Government of India.

- Demonstrated feasibility of operating a 2.5 kW phosphoric acid fuel cell (PAFC) fed by a simulated reformed biogas in collaboration with CISE, Spa, Italy.
- Completed a systems design for demonstration of 10 kW PAFC based on biogas as fuel.
- Designed and fabricated half cell for evaluation of fuel cell electrode in consultation with Johnson Matthey Technology Center, UK under a collaborative research scheme.
- Prepared two major research proposals and obtained funding to the tune of Rs. 20.94 lakhs from the Department of Non-Conventional Energy Sources, Ministry of Energy, Government of India.
- Design of single cell for electrode kinetics study.

Constraints

- Lack of suitable laboratory facilities and inadequate administrative and material inputs. Though the major equipments required for executing sponsored research projects have been identified, the purchase decision has been delayed for one or the other reason.

14. RENEWABLE ENERGY TECHNOLOGY

This is the largest group in TERI and its activities range from laboratory/bench scale research on the one hand to field trials of devices and economic analysis on the other. It so far has functioned without any laboratory space. All experiments are carried out either outdoors or in one converted bathroom.

In brief the objectives of the work are to develop efficient and economic design in solar thermal biomass, biogas and photo voltaic systems which are relevant to Indian conditions and monitor their performance in the field. In addition to systems design, the group is also interested in some basic work on building energy, Phase Change Storage of thermal energy, etc.

The ten projects in operation are: Domestic and Commercial Solar Hot Water, Vaccine Storage, Solar Collector Test set up and system Integration, Solar Pond Liner Test-rig, Solar Assisted Biogas Plants, Biomass Gasifier, Solar Cookers, Passive Architecture, Energy Efficient Bukharis, and assessment of trends in Photovoltaic Cell Technology. Six other projects have been identified for future implementation. These are: Efficient driers, Design methodology for Industrial Hot-Water Systems, Economic and Policy Implications of Emerging Solar Energy Technologies, Medium Temperature Solar Technologies, Solar Safe Drinking Water, and

Thermal Storage in Phase Change Materials. So far the work has progressed well.

Achievements

- Development of cost effective small scale water heater with following characteristics
 - Delivery Temperature: 50° in North India on a winter day (clear) with 15° inlet temperature.
 - Output Range: 30 litres to 200 litres per day.
 - No conventional power is needed to run the system.
 - A patent is being filed for this design.
- Development of a concrete collector to provide hot water in commercial buildings like hospitals, hostels, small scale industries etc.
 - Delivery Temperature: 50°C in North India on a winter day (clear) with 15°C inlet temperature.
 - Output Range: 500 litres to 5000 litres per day.
 - 30 W power is needed on a continuous basis during the day.
 - A patent has been filed for this device.
- Development of a coal-fired space heater (Bukhari) which delivers 80% more heat to the room and pays back for the increase in cost (from Rs. 400 to Rs. 900) in half the winter (3 months, 8 hours/day). Lifetime of the system is estimated to be 20 years (the existing Bukhari lifetime is 1-2 years).

- A patent has been filed for this device.
- A software package (SOLTAR) for estimation of transmission, absorption and reflection of direct and diffuse solar radiation through glass surface has been prepared and a users' manual for the same will be disseminated.
- Publication of the SESI Journal is initiated.
- A 40% reduction is achieved in biogas system installed in the village Dhanawas by improving the design of the plant. The gas production has also increased by 20%.
- Formation of Planters' Energy Network (PEN) is a step in the direction of establishing a link between the researchers and the users.
- An inexpensive thermal storage tank has been developed. (100 litres capacity - Rs. 500 production cost.)

Future Directions

- Development of a 5 HP gasifier based on non-woody biomass fuels for irrigation.
- Preparing a dissemination package for biogas systems, further system improvements through kinetic and reactor design studies with a chemical engineering approach.
- Improving the efficiency of driers used for drying tea, tobacco and cardamon.

- Demonstration of solar pond for process heat.
- Improvement in water heating systems.
- Further design improvement of Bukharis.
- Extensive work on thermal (80% software, 20% hardware) and daylighting (90% hardware and 10% software) aspects of building.
- Development of a solar sterilizer for drinking water.

Constraints

- Inadequate workshop facilities.
- Total absence of laboratory space.
- Shortage of manpower. Additional 4-5 Chemical/Mechanical engineers are needed.
- Difficulty in access to a mini or main frame computer facility.

15. SOCIAL FORESTRY

This is the youngest group in TERI having started its work in July 1986. The objectives are:

- To develop methodologies for testing tissue culture raised plants by the Tissue Culture Group.
- To study the nursery techniques and rates of growth of different tree species suitable for growing on the degraded lands at Gwal Pahari both in line planting and block planting.
- To multiply and test suitable Populus deltoidea

clones for the agroclimatic conditions of Gwal Pahari and Berka Alimuddin. The plant material for starting the work is being arranged from the Research Nurseries of the UP State Forest Department.

- To find out the overall productivity of agriculture crops and trees like poplars and Acacia nilotica var. cupressiformis at Gwal Pahari and Berka Alimuddin.
- To plant and work out the rates of growth for economically viable plantings of bamboos on degraded lands for increasing productivity of such lands.
- Developing superior poplar clones through genetic upgrading followed by their testing in the field.
- To test the effect of mycorrhizae and rhizobium on production of biomass of suitable tree species.

The Group has identified poplars, Acacia nilotica and bamboos for work. The tissue culture plants of elite clones will be tested as soon as they are produced

The genetic improvement programmes are essentially long term and work on this aspect is likely to start after a year as soon as seedlings of known genetic origin are produced in our nurseries.

The Group is also making efforts for allotment of suitable land in the UP hills for developing methodologies for increasing firewood production on the degraded hill sides and to monitor the ameliorative effects of tree planting on such lands. One of the

thrusts will be to develop such technologies of tree farming and agroforestry which the villagers can adopt in their low productivity lands within the economic constraints.

The Group also proposes to lay Seed Orchards for neem, Kala siris, babul, Prosopis juliflora and Jangal Jalebi once the project submitted to NABARD is approved. One model nursery is also proposed to be set up under the same project.

Many institutions in India are carrying out work on micropropagation of forest trees. None of them, however, have the facility to carry out field trials of such plants. TERI is a unique institution in this regard having both laboratory facilities for micropropagation of forest trees as well as for their field testing and studying the rates of growth over comparatively long periods. The institute can therefore serve as a good training ground for those interested in such techniques as well as providing design methodology and field testing facilities for the universities, institutions and forest departments interested in micropropagation of forest trees.

Achievements

- Two nurseries have been set up at Gwal Pahari and Berka Alimuddin. The nurseries have about 40,000 plants which will be ready for planting during coming

planting season.

- Already 1200 plants of babul raised in one of our nurseries in Berka Alimuddin during December 1985, have been planted under our agro-forestry programme.
- About 4000 poplar cuttings will be planted in agricultural fields in January 1987.

Constraints

- Land for long terms experiment is a major constraint. Trees have a long generation and need long term assessment both for production, generation of reliable data and for assessing the ameliorative effects on degraded land.
- Though the availability of technical staff is adequate at present, after two years, the Group would need strengthening with a qualified forest geneticist, pathologist, soil scientist and a few qualified foresters.
- Mist Propagation Facility for vegetative multiplication of elite clones.

SERVICE GROUPS

16. COMPUTER CENTRE

The Computer Centre at TERI is a service group and, inspite of constraints, it has given an excellent backup support. It was established to :

- Anticipate users' software requirements and acquire/develop them
- Promote user awareness by conducting training programmes to acquaint TERI staff with available software facilities.
- Maintain existing software and hardware

The Computer Centre acquired the following micro computers during 1986 :

- An IBM PC-AT with 40 MB hard disk
- An IBM Portable PC
- A SIVA PC
- A direct line has been established to access the Burroughs 6900 System at the Tata Consultancy Services.

Achievements

- Project Monitoring System : Online user friendly software system to monitor the expenditure and activities of ongoing projects in TERI.
- TERIGRAF : An online user friendly Graphics software package.
- Random Sample Retrieval software was developed for the DESU project. This software was developed in an outside organization which had the DESU data. The data was retrieved from their data base, printed and handed over to the Power Policy and Power Systems Group.

- Modification to the existing Regression Package for greater capacity and speed.
- In the existing Solar Radiation Program one more module and additional features have been added. A manual was prepared for this package.
- An Energy Planner Software Package was prepared for the UNESCAP project. A manual was also written. This project is for the application and use of microcomputer and related energy planning methodologies in developing countries.
- Bioinformatics Workshop : This workshop was held in October on behalf of the Department of Biotechnology. Hands on training was given in the use of scientific software on personal computers, in the field of biotechnology and CDS/ISIS library package. Participants were from different government centres in India. Faculty consisted of both Indian and American experts.
- Library catalogue card printing software was revised to reduce the manual work. The catalogue cards for all the books registered in the data base were printed and handed over to Library.
- CDS-ISIS software was acquired and was thoroughly studied and understood. In this process, a software was developed to convert the data from dBASE format to CDS-ISIS. This program will be used to convert all the library data which is now in dBASE format.

- Two training programmes were conducted for TERI computer users. They are introductory courses on Word Processing and LOTUS 1-2-3.
- Inventory :
 - Codification work for the items was done by Administration Department with the help of Computer Centre.
 - System Design : System design for stock and Equipment Modules is complete.
 - Software Development: Software for stock module has been developed.

Constraints

- Frequent breakdown of
 - Pragati System
 - Zenith Professional
 - Zenith PC (2 Machines)
- Poor maintenance support for Pragati and Zenith Systems.
- Shortage of space for hardware.
- Seasonal extra load on word processing.
- Need for a high speed letter quality printer.

We think that the following will contribute to the centre giving more efficient service to users.

- Replacing the Pragati and Zenith Systems with the latest dependable systems.
- To improve maintenance we could either opt for an

inhouse maintenance engineer (particularly since we are going in for more systems) or let a single, reliable maintenance group to maintain all the systems.

- TERI now needs a single room to house all the systems at 7 Jor Bagh. This would also help in temperature and dust control. Air conditioning would be more economical.
- An additional letter quality printer - preferably QUME Sprint 11.

Future Directions

- Automation of the administrative services of TERI (Payroll, Financial Accounting, Purchase Monitor) is to be undertaken in the coming year.
- Intensive training programme in DOS, BASIC, LOTUS, CDS/ISIS and DBASE III every month. This has already begun.

17. INFORMATION SYSTEMS

The TEPI Information Systems, consisting of three units - Library, Documentation & Information Centre and a Publication Unit - is a very important input to the progress of any research and development institute in furthering its objectives. It is heartening to see that the Library has been totally transformed during the last

six months and today TERI is on its way to have a well organized Library and an integrated information system.

LIBRARY

Achievements

- The collection comprises of 6000 technical books, around 300 periodical titles (through subscription or exchange), 3000 back volumes of periodicals, and statistical and other Government documents. Nearly 5000 volumes are expected as gift from IDRC. For easy accessibility, a computer generated author-subject catalogue has been provided in the Library. Other user services include reference; circulation; inter-library loan; compilation of bibliographies; display of press clippings; circulation of an annotated list of new acquisitions; conducting literature searches; and answering reference queries.
- Steps have been taken towards modernization through information management by computer applications. Two major software packages available with us for information storage and retrieval applications are UNESCO's Micro CDS/ISIS and one from the Institute for Scientific Information (U.S.A.) called SCIMATE. These are being used to create bibliographic databases as well as to manage in-house operations like circulation and serials control.

Constraints

- The major constraint at the moment is paucity of space. For creating a proper reading environment as also to increase the usage of Library (which for want of space is rather low), it is necessary that additional space has to be found out on priority basis. The immediate requirement is of the order of 80-100 sq. meters.

Future Plans

- Once the space problem is overcome, it is aimed to make TERI Library collection a pioneering source of energy information in the country as also in the South Asia Region by pursuing active collection development. It is also proposed to establish comprehensive exchange programme with major institutions engaged in energy research. A more fuller exploitation of the information package is envisaged, finally leading to far reaching benefits like networking, resource sharing, universal accessibility and availability of information. All these changes would eventually help in making the Library more useful for readers within and outside TERI. Incidentally, it shows what can be achieved by the induction of a competent professional.

PUBLICATIONS

Publications form an integral part of the TERI information system. It is through its publications that an institution is able to project its ideas to the outside world. Apart from the in-house publications like discussion/research papers, reports and proposals, regular publications include a bi-annual journal entitled Pacific and Asian Journal of Energy (PAJE) a quarterly Journal of the Solar Energy Society of India as well as its Newsletter.

DOCUMENTATION

Steps for shifting the Documentation and Information Centre to N. Delhi were complete towards the close of 1986 and the Centre has now started functioning from its new premises at 7, Jor Bagh. The objectives and goals of the Centre have subsequently been redefined and the Centre is now poised to provide extensive documentation support for in-house research while at the same time continuing to be the premier energy information facility for India.

Achievements

- For inhouse documentation support, the Centre is developing a set of databases on specific energy technologies and systems. About 7 such data bases consisting of over 17,000 records have been developed

during the course of the year using two specialised software packages namely SCIMATE and CDS/ISIS. The centre has installed a Zenith Professional 86 plus with 40 MB winchester for information storage and retrieval.

- In addition, the Energy Information Service which periodically highlights national and international advances in select thrust areas of TEPI has also been initiated. This information service is being received with enthusiasm by the inhouse research teams and in several cases service has led to conducting retrospective literature search on very specific technologies/problems.
- A brief documentation on Passive Solar Cooling has also been prepared for limited circulation among the members of the Renewable Energy Research Group of TERI.
- At the national level, the Centre continued to provide reference, referral and document back-up service to over 1000 institutions and individuals involved in energy R&D. As many as 9 issues of Energy Digest and 2 issues of Indian Energy Abstracts have been published during 1986. Presently, formalities for re-registering these publications in New Delhi are in progress.
- Meanwhile, under the regular programme of information analysis and consolidation a technology profile of Fuel Cells and an information package on Energy

Modelling have also been prepared.

Constraints

- The major limiting factor so far has been the shortage of human resources, computer time, photocopying facility, space etc. As for human resources, the Centre is presently having the services of three information professionals, one data entry operator and a secretary. Considering the tasks in hand, the services of at least 2 more professionals and a library attendant would be required in the immediate future.
- Paucity of computer time is found to be yet another constraint in the successful implementation of programmes. Activities related to the preparation of data base, publication of Energy Digest and Indian Energy Abstracts, retrospective and current literature search etc would require the use of the Zenith Professional for about 7-8 hours a day. Further word processing work in connection with the publication of Energy Digest and the preparation of information packages would demand the use of a PC for at least 2-3 hrs a day.

Presently efforts for putting the services back on the rail are in full swing and the required infrastructural facilities in terms of manpower, space,

computer and other equipments etc are also being established.

Future Plans

The performance of the Centre during the past decade has attracted the attention of several national and international organisations like FWD of the Netherlands, UNESCO, UNU, UNEP etc. These organisations have offered to sponsor some of the information consolidation and dissemination programmes of the Centre. Some of the projects that will be undertaken during 1987-88 are indicated below:

- A pilot project for the repackaging of Scientific and Technological Information for Developing Countries is being sponsored by UNESCO. Work on the preparation of a set of 3 information repackages on bio gas technology have been initiated.
- The United Nations University, Tokyo has entrusted TERI the work of publishing the Abstracts of selected solar Energy Technologies (ASSET).
- Further, the centre will serve as the Special Sector Source of INFOTerra, UNEP for information dissemination on energy-environment interface.
- Meanwhile, a project for the compilation of exhaustive Resource Index on Cookstoves is likely to be sponsored by the FWD, Netherlands. Recently, it has been proposed to compile a Directory of Wood

Energy Institutions in the Asia-Pacific; this is expected to be sponsored by the FAO Regional Wood Energy Development Programme, Thailand.

APPENDIX III: PUBLICATIONS OF TERI STAFF

1. DATA SYSTEMS

Paper Published/Accepted for Publication

Dunkerby, J., Hock, I., Thukral, K. and Gadhok, C., Energy and Transport: The Indian Experiences. (Accepted by PAJE, New Delhi).

Paper Presented

Thukral, K. and Ramesh S., 1986. Alternative Scenario of Energy Demand for Lift Irrigation: A Case Study for Uttar Pradesh State in India. Annual Meeting IAEA, Tokyo.

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Pachauri, R.K. and Thukral, K. (Eds), 1985, Energy Policy Issues, Allied Publishers, New Delhi.

Reports

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Thukral, K., 1984. Energy Data Base for India. Submitted to the UP University, Tokyo.

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2. ENERGY ENVIRONMENT INTERFACE

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- Pandya, J.D., 1985. Energy Use and Environmental Effects: Atmosphere Air Pollution in Delhi. Energy Environment Monitor 1(2): 21-30.
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Papers Presented

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- Gadgil, A. 1985. Indoor Air Quality in Offices and Hospitals in High Altitude Himalayas. Submitted to the 4th International Conference on Indoor Air Quality and Climate, Berlin (West).
- Joshi, V., Venkataraman, C. and Ahuja, D.P., 1985. Performance of Cookstoves: Measurements of Thermal Efficiency and Emissions. Presented at the World Congress on Engineering and Environment, New Delhi.
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Book

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4. FOSSIL ENERGY

Papers Presented

Sridharan, P.V., 1986. Coal Demand and Supply. Presented at the Seminar on Energy Planning and Demand Management. Nainital.

Mathur, A., 1986. Energy Conservation Potential of Fluidized-Bed Furnaces. Presented at the Nainital seminar on Energy Conservation in the Chemical and Allied Industries, Kanpur.

5. INDUSTRIAL ENERGY EFFICIENCY

Papers Presented

Kothari, V.S., 1985. Energy Conservation in Industry: New Technologies and Developments. Presented at the Annual Convention of the Indian Management Association.

Kothari, V.S., 1986. Strategies for Improving Efficiency of Electric Motors in Industry and Agriculture. Presented at the Workshop on Energy Policy Issues, Jaipur.

Sambasivam, G., 1986. Industrial Energy Policies: National and International Scene. Presented at the Workshop on Energy Policy Issues, Jaipur.

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Bhattacharya, D., 1984. Waste Heat Recovery through Cogeneration in Selected Industries in India.

Bhattacharya, D. and Natarajan, T.V., 1985. Industrial Energy Use at the National Level: Use of Secondary Data.

Kothari, V.S., 1985. Industrial Energy Policies of India.

6. POWER SYSTEM AND POLICY GROUP

Papers Published/Accepted for Publication

Ramesh, S. 1985. Electricity generation expansion models, In : 'Integrated Energy Planning - A Manual', Asian and Pacific Development Centre, Publ, Kuala Lumpur.

Ramesh, S. and Natarajan, B. 1986. Policy options for rural

energy technologies in India (Accepted for publication in Pacific and Asian Journal of Energy).

Papers Presented

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Anonymous, 1984. Pre-investment study on thermal power station in Rajasthan. Submitted to Rajasthan State Industrial Development and Investment Corporation, Jaipur.

Anonymous, 1986. A study of the characteristics of DESU load demand-Mocule-I. Submitted to Delhi Electric Supply Undertaking.

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7. RURAL ENERGY RESEARCH AND EXTENSION

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Bose, R.K. Dey, A. and Banerjee, A.K. 1982. A simple rule for stratification, J. Indian Soc. Agric. Stat.

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Ahuja, D.R., 1986. "Health Effects of Domestic Smoke". Workshop on Impact of Improved Stoves, Consortium on Rural Technology : New Delhi.

Joshi, V., 1986. "Evaluation Framework for Cookstoves Programme". Workshop on Impact of Improved Stoves, Consortium on Rural Technology, New Delhi.

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Papers Presented

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10. CHEMICAL ENERGY

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- Gadgil, A., "Economic, Materials and Performance Constraints for a DHW System for Use in India. (Accepted by SESI J.).
- Gadgil, A. Energy Technologies for Mountain Development. In: Ahuja, D.R. (Ed.) *Rural Energy in Hindu Kush-Himalaya* To be published by ICIMOD.
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- Kishore, V.V.N. Assessment of Natural Cooling Potential for Buildings in Different Climatic Conditions. (Accepted by Building and Environment, Pergamon Press).
- Kishore, V.V.N., Rao, R. and Raman, P. A Portable Shallow Solar Pond Water Heater. (Accepted by Solar and Wind Technology, Pergamon Press).
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Papers Presented

- Gadgil, A. 1984. Convection in Building-State of the Art. Invited paper at the International Workshop on Energy Conservation in Buildings, Central Building Research Institute, Roorkee. Published by CBRI in the Proceedings of the Workshop.
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on Energy for Development published by Afro-Asian Rural Reconstruction Organization, New Delhi.

- Gadgil, A., 1986. Improving End Use Efficiency and Tapping New Resources of Energy for Hill Area. Proceedings of the Seminar on Alternative Energy Systems for Hill Areas, Lucknow, Published by SHERPA.
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- Kishore, V.V.N. and Katam, S. 1985. Thermal Conductivity Improvement of Paraffin Wax for Thermal Storage Applications. Proceedings of the 7th Miami International Conference on Alternative Energy Sources.
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- Kishore, V.V.N., Ranga Rao, V.V. and Raman, P. 1986. A Shallow Solar Pond Domestic Hot Water Systems. Presented at the NSEC, Madurai.
- Meier, P. and Gadgil, A. 1984. Use of Micro-Computers in Energy Planning in Developing Countries. Proceedings of the Fifth International Conference of International Application of Energy Economics, New Delhi, Allied Publishers, New Delhi.
- Prakash, G., Rastogi, S., Gadgil, A. and Kishore, V.V.N., 1986. Comparison of Various Renewable Energy Options to Meet Energy Demand of an Urban Community. Presented at the NSEC, Madurai.
- Raman, P. and Kishore, V.V.N., 1986. Performance of a 10m^3 Fixed Dome Biogas Plant at a T.B. Sanatorium. Presented at the NSEC, Madurai.

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Kishore, V.V.N., Ranga Rao, V.V. and Raman, P., 1986. Some Problems of Implementation of Biogas Technology in Rural Areas.

13. SOCIAL FORESTRY

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Cheema, G.S. and Mehra, P.N., 1985. Studies in Cactus Seed Germination and Seedling Growth in vitro. J. Nat Cactus and Succ. Soc. (India), 5:17-26.

Mehra, P.N. and Cheema, G.S., 1985. Differential Response of Male and Female Himalayan Poplar (Populus citiata and P. alba) in vitro. Phytomorphology. 35:151-154.

Pachauri, R.K. and Dhawan, V., 1987. Potential for Hydrocarbon Plantation in India. Science Age. 4. 22-229.

Papers Presented

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Chaturvedi, A.N., Moinbasha, S and Jagannathan, V., 1986. "Technologies for the Utilizataion and reclamation of waste lands"; South-East Asia Regional Workshop on the Economics of Dryland Degradation and Rehabilitation, Society for Promotion of Wasteland Development, New Delhi.

Cheema, G.S., 1986. "Tissue culture of Agro-forestry Trees". Symposium on Plantations: Opportunities in India, Hindustan Lever Research Foundation, New Delhi.

Cheema, G.S., 1986. "Tissue Culture of Poplars: Problems and Prospects". Indo - U.S. Meeting on Social Forestry, Indian National Science Academy and American Association for Advancement of Science, New Delhi.

Cheema, G.S., 1986. Social Forestry and Forest Biotechnology Research Activities in TERI. In: Northern Regional Meeting of Silviculturists and Research Workers. Forest Training Research Institute, Haldwani, U.P.

Dhawan, V., 1987. Enhanced Biological nitrogen fixation by application of biotechnology. Paper presented at UNU Workshop on Nitrogen Fixation, Chulalongkorn University, Bangkok, Thailand.

Dhawan, V., 1987. Tissue culture propagation in tree legumes. Workshop on Agroforestry for Rural Needs. Vigyan Bhawan, New Delhi.

Khoshoo, T.N. 1986, Ecosystem vs. Socio-economic system. Presidential address. 56th Annual session. The National Science Academy, Allahabad. 1-10.

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Khoshoo, T.N. 1985. Environmental Priorities in India and Sustainable Development. Presidential Address 73rd Session, Indian Science Congress Association, Calcutta. 1-224+1-XXIV.

Khoshoo, T.N. 1986, (Ed) Ecodevelopment of Alkaline Land : Banthra - A case Study. NBRI, Lucknow. 1-142.

**APPENDIX IV: LIST OF TRAINING PROGRAMMES/SEMINARS/WORKSHOPS CONDUCTED BY
TATA ENERGY RESEARCH INSTITUTE**

Sl. No.	Title of the Programme	Programme Coordinator	Duration	Collaboration with/ Sponsorship of	Venue	Number of Participants
1		2	3	4	5	6
1982						
1.	International Workshop on "National Energy Data Systems"	Dr. R.K. Pachauri	15-18 Dec. 82	With support from various national/ International Organisations.	IIC, New Delhi	62
1983						
1.	Seminar on "Conservation of Energy in Cement Industries"	Dr. D. Bhattacharya	9th May, 83	Madhya Pradesh Electricity Board, Jabalpur.	Jamul (MP)	75
2.	Workshop on Environment Guidelines for Coal Transportation"	Dr. D.R. Ahuja	14-17 Nov., 83	Dept. of Environment Government of India.	Hotel Taj Palace, New Delhi.	32
1984						
1.	Training Programme on "Planning for the Power Sector"	Dr. S. Ramesh	23-28 April, 84	CEA, New Delhi	Centaur Hotel, New Delhi.	22
2.	Workshop on Energy Policy Issues: National and International Perspectives"	Dr. R.K. Pachauri	14-16 July, 84	Department of Petroleum, Govt. of India.	Rambagh Palace Hotel, Jaipur.	33
3.	Training Course in Energy Planning and Management	Dr. R.K. Pachauri	24-29 Sept., 84	APDC, Kuala Lumpur. EAPL, Honolulu	Hotel Mansingh, Jaipur.	31 + 14*
4.	Training Programme on "Energy Data Systems"	Dr. R.K. Pachauri	13-15 Dec., 84	Department of Personnel, GOI.	Vigyan Bhawan, New Delhi.	42

*Foreign Participants

1	2	3	4	5	6
<u>1985</u>					
1. Training Programme on "Energy Pricing"	Dr.S. Ramesh	14-16 Feb., 85	Department of Personnel, GOI.	Vigyan Bhavan, New Delhi.	36
2. Training Programme on "Planning for the Power Sector"	Dr.S. Ramesh	16-21 April, 85	CEA, New Delhi.	West View Hotel, Ranikhet (UP)	28
3. Workshop on "Breeding of Oil Producing Mustard"	Dr. Deepak Pant	26th April, 85	—	TERI Conference Room	15
4. Round Table Discussion on "Oil Exploration"	Dr. R.K. Pachauri	25th May, 85	—	IIC, New Delhi	16
5. Workshop on "Rural Energy Planning"	Dr. D.R. Ahuja	29th June, 85	ICIMOD	IIC, New Delhi	
6. Workshop on "Plastics for Solar Thermal Applications"	Dr. A.J. Gadgil	16th Aug., 85	—	IIC, New Delhi	15
7. Meeting on "Potential for Bio-Technology in Indian Industry"	Dr. R.K. Pachauri	24th Aug., 85	—	IIC, New Delhi	37
8. Workshop on "Concrete Solar Water Heating Systems"	Dr. A.G. Gadgil	30th Aug., 85	—	TERI Conference Room	11
9. Workshop on "Fuel Cells"	Dr. J.D. Pandya	28th Sept., 85	D.N.E.S.	IIC, New Delhi	30
10. Workshop on "Energy Policy Issues"	Dr. R.K. Pachauri	14 & 15 Oct., 85	Ministry of Petroleum	Pambagh Palace Hotel, Jaipur.	30
11. National Workshop on the "Environmental Management on Thermal Power Station"	Dr. D.R. Ahuja	20-22 Nov., 85	DOE, GOI.	Ashok Hotel, New Delhi.	44
12. Workshop on "Non-Conventional Energy Planning and Utilisation"	Dr. A. Gadgil	11-13 Dec., 85	Department of Personnel, GOI.	Vigyan Bhavan, New Delhi.	44

1	2	3	4	5	6
<u>1986</u>					
1. Workshop on "Energy Efficient Building Design"	Dr. R.K. Pachauri	6th Jan., 86	—	Taj Palace Hotel, New Delhi	44
2. Seminar on "Energy Pricing"	Dr.S. Ramesh	12-14 Feb., 86	Department of Personnel, GOI.	Vigyan Bhawan, New Delhi.	40
3. Training Programme on "Economic Analysis"	Dr. R.K. Pachuri	15&17 Feb., 86	GAIL, NEW DELHI	TERI Conference Room	14
4. Workshop on "Energy Modelling"	Dr. R.K. Pachauri	28th Feb., 86	ABE, New Delhi	IIC, New Delhi	35
5. Workshop on "Energy Management in Industrial Sector"	Mr.V.Kothari	12-14 March, 86	Department of Personnel, GOI.	Vigyan Bhawan, New Delhi.	48
6. Training Programme on "Planning for the Power Sector"	Dr.S. Ramesh	12-17 April, 86	CEA, New Delhi	Hotel Oberoi Clarkes, Simla	30
7. ESCAP Programme on "Energy Planning"	Dr. R.K. Pachauri	16-27 June, 86	ESCAP	Kathmandu	15
8. Workshop on "Economic Analysis"	Dr. R.K. Pachauri	12&14 July, 86	GAIL, New Delhi	TERI Conference Room	18
9. Workshop on "Innovative Techno- logies in the Electric Power Sector: Moving from R&D to Commercial Applications"	Dr. S. Ramesh	21st August, 86	USAID	I. I. C. New Delhi	40
10. Refresher Course for IAS Officers on "Rural Energy Planning and Technology"	Dr.Veena Joshi	8-13 Sept., 86	Department of Personnel, GOI	HP Institute of Public Administration Simla	24
11. Refresher Course for IAS Officers on "Energy Planning Energy Demand and Management"	Dr.V.Deshpande Dr.B.Natarajan	20-25 Oct., 86	Department of Personnel, GOI	Administrative Training Institute, Institute, Nainital.	20
12. Workshop and Training Programme in Bio Informatics	Mrs. Hema Narayanan	27th Oct. to 1st Nov., 86	Dept. of Bio- Technology, New Delhi.	Ashoka Hotel New Delhi	40
13. ESCAP Programme	Dr. R.K. Pachuri	9-20 Nov., 86	ESCAP	Bangladesh	13

1	2	3	4	5
14. Workshop on "Energy Modelling"	Mrs. Leena Srivastava	7th Nov., 86	ABE, New Delhi	TERI Conference Room
15. Workshop on "Economic Analysis"	Mrs. Leena Srivastava	24th Nov., 86	GAIL, New Delhi	TERI Conference Room
16. Workshop on "Energy Management in Industrial Sector"	Mr. V.S. Kothari	24-26 Nov., 86	Department of Personnel, GOI	Vigyan Bhavan, New Delhi
17. Workshop for CINTREP	Dr. Ashok Gadgil Dr. B. Natarajan	17&18 Dec., 86	UNESCO	IIC, New Delhi
18. Seminar on "Energy Pricing"	Dr. S. Ramesh	17-19 Dec., 86	Department of Personnel, GOI	Vigyan Bhavan, New Delhi.
19. Workshop on "Energy Policy Issues"	Dr. R.K. Pachauri	19&20 Dec., 86	Ministry of Petroleum, GOI	Rambagh Palace Hotel, Jaipur.

1987

1. Training Programme on Energy Planning for South Asian Countries.	Dr. R.K. Pachauri	23-28 March, 87	C.E.C., Brussels.	Hotel Fort Aguada, Goa.
2. One week Refresher Course on Natural and Man Made Forest for Energy Needs and Environment Conservation.	Mr. A.N. Chaturvedi	16-21 March, 87	Min. of Environ- ment & Forest	Taj Palace, N.D.
3. Training Programme on Planning for the Power Sector	Dr. S. Ramesh	6-11 April, 87	CEA, New Delhi	Savoy Hotel, Ooty.

TO BE ORGANIZED

4. One day Workshop on "Leucaena Leucocephala"	Dr. R.K. Pachauri	25 April, 87		TERI Conference Room
5. One week Refresher Course for IAS Officers on "Rural Energy Planning and Technology"	Dr. V. Joshi	11-16 May, 1987	Dept. of Personnel	ATI, Nainital
6. One week Refresher Course for IAS Officers on "Energy Planning and Energy Demand Management"	Mr. G. Sambasivan Mrs. Leena Srivastava	5-10 Oct., 87	Dept. of Personnel	Taj Palace New Delhi
7. Workshop on "Energy Management in Industrial Sector"	Mr. V. Kothari	9-11 Nov., 87	Dept. of Personnel	Vigyan Bhavan, New Delhi.

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8. Seminar on
"Energy Pricing"

Dr. S. Ramesh

21-23
Dec., 87

Dept. of Personnel Vigyan Bhavan,
New Delhi.

34

9. Workshop on
"Energy Policy Issues"

Dr. R.K.
Pachauri

Dec., 87

Rambagh Palace
Hotel, Jaipur.

25

10. ESCAP Programme

(Dates to be fixed)

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23

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